UNIDIRECTIONAL FIBER REINFORCED SHEETS IN A THERMOPLASTIC MATRIX

FIELD OF THE INVENTION

[0001] The present invention relates to the field of civil structures, and more particularly to concrete columns used to support overhead loads. It is a process of improving the ductility and resistance to shear of existing concrete support columns when they are subject to atypical loading, such as is encountered in earthquakes.

BACKGROUND OF THE INVENTION

[0002] The growth of world population has forced society to take on a multi-level configuration in certain locales, such as in cities and along heavily-traveled highways. Office buildings, high-rise apartment buildings and freeways are often built using concrete columns to support overhead levels, spans or structures. These columns vary in width and height and may be reinforced with internal steel rods. Once in place, the physical characteristics of concrete columns become frozen, and they are difficult, if not impossible, to remove, repair or alter without placing the overhead load in jeopardy.

[0003] Earthquakes historically have caused damage to civil structures. Mild quakes often cause cracks in the surface of columns, while stronger quakes can actually cause them to collapse. The loads imposed on concrete columns in an earthquake may include a combination of lateral shifting and displacement, vertical movement in both directions, and torsional stress or twisting. Where the column does not collapse from this loading, it is often left in a damaged condition that will require repair or replacement before the structure which it is supporting is available for reoccupation. It is to these mild-to-moderately damaged columns, as well as undamaged columns, that this invention is directed.

[0004] Columns most often are set in or on a solid surface where the base of the column cannot move laterally. The load from above, however, may be fixed or pinned to the top of the column; in the latter configuration, the load and the column may move independently of each other. In the first case, called the "double bending" mode, sideways shifting of the column base, such as may occur in an earthquake, will place a bending moment on the column that is greatest in one direction at its base and greatest in the opposite direction at its top with the gradient acting

linearly therebetween, so that at some point along the column, usually the midpoint, the moment is zero. Where the load is pivotally mounted on the column, only a single moment is generated when the base or top is subjected to lateral force, and this is at its base. This is called the "single bending" mode. When the column is subjected to uplifting or central acting force, such as in an earthquake involving ground upheaval, a shear force is applied to the column substantially along its entire length.

[0005] The earthquake near San Francisco in 1989 revealed that many existing concrete columns that support bridges, elevated highways or other overhead loads, are insufficiently ductile and lack sufficient strength to withstand these moderate to severe transient tremors. Replacing the concrete column with a stronger one poses a long-term solution to the problem, that may not be complete before the next earthquake occurs, and also poses a severe financial burden to the community. Repairing the columns in place has been accomplished mainly by surrounding a portion of the damaged column with a steel or strong metal jacket. This procedure has resulted in definite strengthening of the column; however, the costs involved are significant. Other attempts by the prior art to strengthen columns are by processes similar to that shown in U.S. Patent No. 4,892,601, which is to fit a compressible elastomeric interlayer about the columns so as to mechanically bind the interlayer to the column, fitting a sleeve around the column clad with the elastomeric interlayer and filling the clearance between the interlayer and the sleeve with a flowable, hardenable composition essentially free from shrinking on hardening, and allowing the composition to harden so as to form a solid core mechanically bonded to each of the interlayer and the sleeve. This process, however, does not solve the problem associated with the transient loads that are applied to columns during an earthquake.

[0006] Accordingly, there remains a significant problem in the industry to strengthen an existing column, under load, to significantly increase its ability to survive a moderate to severe earthquake and to sustain its support function during the fluctuating loads that occur therein.

[0007] Prior art exists for a shell-type system of retrofit and for the injection of grout into the annular space of the repaired column.

SUMMARY OF THE INVENTION

[0008] The present invention relates to the use of thermoplastic sheets, which allows the flexibility of providing differing thicknesses of sheet, as opposed to layers of shells, in order to meet the design criteria for a given retrofit solution. In addition, no adhesive is required, as the thermoplastic lap joint may be welded by various methods, including ultrasonics as the preferred method. Following wrapping, the annular space may be filled with an expansive grout to prestress the jacket system. Thus, by the method of the present invention, the "shell" is placed, followed by the filling of the annular space.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009] The present invention is related to a process for increasing the strength and ductility of a column while it is under load, and in place, in order to better withstand the increased physical loading accompanying an earthquake. Note that prior art exists for a shell-type system of retrofit, and for the injection of grout into the annular space of the repaired column. In the present invention, the use of thermoplastic sheets allows the flexibility of providing different thicknesses of sheet, as opposed to layers of shells, in order to meet the design criteria for a particular retrofit system.

[0010] Specifically, in a concrete column supporting an overhead load and having a base and resting on a surface, the present invention relates to a process of strengthening the column to increase its ability to withstand atypical physical loading accompanying an earthquake, comprising the steps of: (a) defining a work area about the surface of the column to which said strengthening is to be applied, said work area defined by circumferential marginal edges arranged in spaced-apart relation about the column; (b) overwrapping said work area with at least one layer of a unidirectionally reinforced thermoplastic sheet, said sheet wrapped around the column; (c) welding said sheet to said column; and (d) injecting a filler into an annular space between the sheet and the column, following welding. In a preferred embodiment, the sheet has a thickness of from about 0.1 mm to about 3 mm.

[0011] In addition, adhesive is not required, as the thermoplastic lap joint may be welded by various means, including, e.g., ultrasonics. Following wrapping, the annular space may be filled with an expansive grout, in order to prestress the jacket system.

[0012] A further advantage to the use of thermoplastics is the recyclability/reformability of these materials, which will reduce scrap rates both in-plant and on-site. Sheets will be easy to transport over bulkier shells, with less need to pre-measure and "custom-make" each retrofit system for each different sized column.

[0013] A further advantage of the present invention is the reduction of problems from environmental conditions (e.g., moisture, dust, etc.), which may be a problem for systems involving uncured resins and/or adhesives. Furthermore, the column preparation stage (e.g., filling by patching, etc.) by injecting grout afterward may be able to be avoided.

[0014] In a further embodiment, the use of the type of sheet described above may be carried out, except that the joint would have a tightening apparatus, and the column would be "prepped" with a thick layer of an adhesive. The sheet would be placed around the column and around the adhesive, and the overlap joint would be winched in a tight manner, and then welded.

[0015] While this invention has been described with respect to particular embodiments thereof, it is apparent that numerous other forms and modifications of this invention will be obvious to those skilled in the art. The appended claims in this invention generally should be construed to cover all such obvious forms and modifications which are within the true spirit and scope of the present invention.